4

THE WEDDERBURN METEORITIC IRON

By A. B. Edwards, D.Sc., Ph.D., D.I.C.

[Read 11 October 1951]

Introduction

The examination of the Wedderburn meteorite was undertaken as part of the research programme of the Mineragraphic Section of the Commonwealth Scientific and Industrial Research Organization, by whose permission it is published. The meteorite is specimen Reg. No. 11893, Geological Museum, Mines Department, Victoria. It was found by Mr. C. Bell, of Rushworth, when prospecting at a point three miles north-east of Wedderburn. He kicked it on the side of the road, noticed that it was very heavy, and thought it might contain gold—which, incidentally, it does. It appeared to be a complete meteorite, with well rounded surfaces, and shows a characteristic 'thumb mark'. It weighed 210 gm. and its overall size was 5 cm. × 3·6 cm. × 2·6 cm.

Chemical Composition

Chemical analysis of the Wedderburn meteorite reveals that it is an iron meteorite, containing about 24 per cent of nickel (plus cobalt). It thus has the distinction of being the most nickel-rich meteoritic iron yet found in Australia. Iron with 30, 35 and even 62 per cent nickel have been found in Brazil, and in the United States (Perry, 1944). Table 1 shows the composition of the Wedderburn iron, compared with other nickel-rich irons found in Australia.

Table 1

Chemical Composition of the Wedderburn and other Australian Meteoritic Irons

	1.	2.	3.	4.
Fe	74·35	82·29	85·31	85·66
Ni	23·95	16·90	13·18	13·56
Co	0·50	1·09	1·04	0·77
S	0·16	abs.	0·01	tr.
P	0·78	abs.	0·22	0·05
C	0·03	0·03	0·02	tr.
	99·77	100·31	99·81	100·04
Sp.Gr.	8·025	8·00	7·805	7·967

1. Wedderburn (*Analyst*: G. C. Carlos, Mineragraphic Section, C.S.I.R.O.).
2. Tawallah Valley, Roper River District (Hodge-Smith and Edwards, 1941).
3. Cowra, N.S.W. (Mingaye, 1904).
4. Mount Magnet, W.A. (Simpson, 1927).

The specific gravity of the main portion of the meteorite (159 gm.), which has been preserved, is 8·025, and it is probable that the specific gravity of the fresh iron is a little higher than this. The effect of surface weathering on the density was established on a sawn-off fragment with a rust-coated surface. With its rust coating untouched the fragment had a specific gravity of 7·784. After grinding away much of the coating the density increased to 7·899, and after a further grinding, to 7·94. Some rusted α-iron was still present.

Microtexture

In the unetched polished section numerous irregular bodies of creamy-brown iron-nickel phosphide, and less numerous small bodies of darker brown troilite (FeS) can be distinguished dispersed through the iron; and it can be seen that the iron-nickel phosphide bodies are generally rimmed by a narrow zone of iron that is softer than the iron as a whole. Several of the troilite bodies show an intimate micro-intergrowth with iron, and one or two are associated with a little carbonaceous matter. Grains of gold were observed. associated with the phosphide in one section.

A light etching with 2% nitric acid in alcohol, or with 20% aqueous ferric chloride, brings out an incipient Widmannstätten texture (Pl. II, figs. 1 and 2), comparable with that found in other nickel-rich irons, such as the Tawallah Valley iron (Hodge-Smith and Edwards, 1941). The etching reveals that the iron-nickel phosphide bodies, which are up to 0·05 mm. × 0·05 mm., are distributed more or less uniformly through the iron, and variously oriented, with a tendency to lie parallel to the octahedral planes of the iron, and that they are commonly enclosed by narrow rims of α-iron, up to 0·05 mm. thick (Pl. II, fig. 1). Occasional phosphide bodies have no such rim, others have the rim on one side only. The apparent width of the α-iron rim varies with the orientation of the phosphide bodies and their rims relative to the plane of the polished section. Occasionally the plane of the section lies wholly in a rim of α-iron (Pl. II, fig. 1).

In the interspaces between the phosphide bodies are areas which with light etching appear to be predominantly γ-iron carrying clusters of minute lens-like bodies of α-iron, the α-iron bodies being oriented parallel to the octahedral planes of γ-iron (Pl. II, figs. 1 and 2). Close inspection of the clear matrix between the α-iron bodies show that it is finely mottled, and with more severe etching it darkens. Very high magnification reveals that it is an extremely fine-grained intergrowth of bodies of α-iron that grade down to sub-microscopic sizes, in a γ-iron matrix, the α-iron bodies being oriented like the visible α-iron bodies shown in Pl. II, figs. 1 and 2), forming a so-called 'plessite' intergrowth.

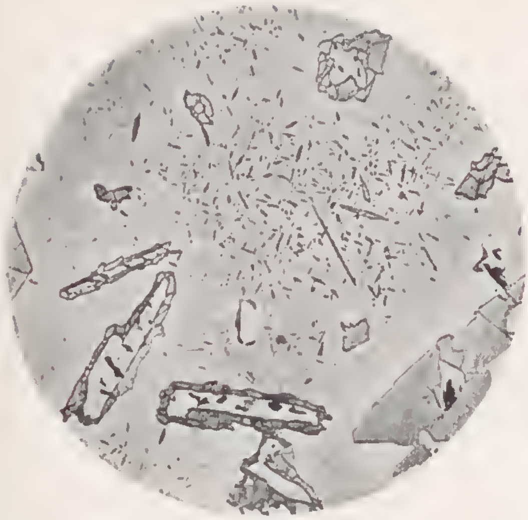
The γ-iron adjacent to the phosphide bodies and the coarser oriented α-iron bodies has been 'drained' free of α-iron by solid diffusion, and segregation to the larger areas of α-iron. This feature is more apparent with stronger etching, which leaves the 'drained' areas unetched, while the sub-microscopic intergrowths of α-iron and γ-iron appear black at all but high magnifications.

The marginal 2 to 3 mm. of the meteorite remains practically unetched by weak nitric acid, because here rapid chilling has prevented any fine precipitation of α-iron bodies, and all the matrix iron is in the γ-form, with a nickel content comparable with the overall nickel content of the iron.

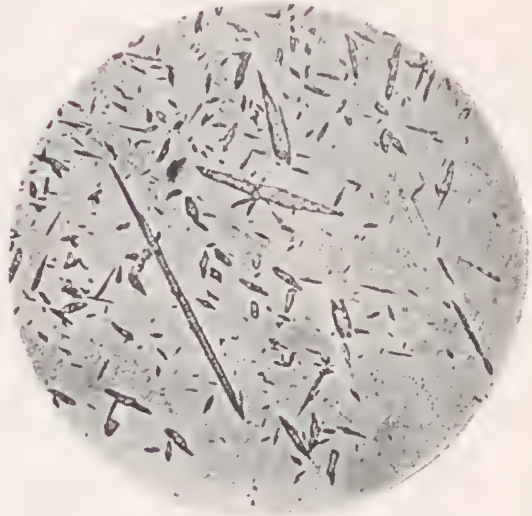
The α-iron and γ-iron are readily distinguished by their etching behaviour:

α-iron: positive—HNO_3, $FeCl_3$, $HgCl_2$.
negative—HCl(?), KOH, KCN.
γ-iron: negative—HNO_3, HCl, KOH, KCN, $FeCl_3$, $HgCl_2$.

The α-iron, moreover, rusts readily on exposure in the polished surface, whereas the γ-iron does not (Pl. II, fig. 3).

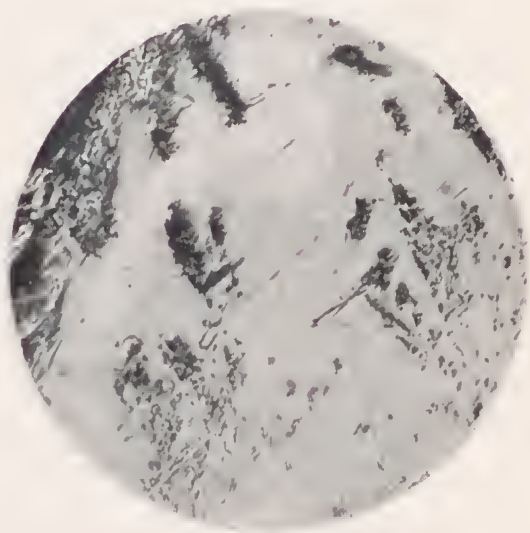


1



2

3



4

Fig. 1.—Wedderburn iron, lightly etched with 2% nitric acid in alcohol. The hard white bodies are schreibersite, rimmed with α-iron, and the oriented small dark bodies within them are α-iron. The matrix is a fine intergrowth of α-iron and γ-iron, except in the vicinity of the large bodies of α-iron, where it consists only of γ-iron. × 150.

Fig. 2.—Part of the field of view of Fig. 1, magnified, showing the duplex nature of the matrix. × 450

Fig. 3.—Differential rusting of α-iron (dark). The relatively homogeneous area is on the edge of the structureless marginal portion of the iron. × 75.

Fig. 4.—Area of gold (light grey) in unetched iron (medium grey), at the edge of the specimen. Dark areas are pits. × 500.